DIRECT TESTIMONY
OF
JOSEPH WADE RICHARDS

Table of Contents

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ON BEHALF OF

SOUTH CAROLINA ELECTRIC & GAS COMPANY

DOCKET NO. 2017-370-E

Q. PLEASE STATE YOUR NAME, BUSINESS ADDRESS AND POSITION.

A. My name is Joseph Wade Richards. My business address is 601 Old Taylor Road, Mail Code J37, Cayce, South Carolina 29033. I am employed by South Carolina Electric & Gas Company ("SCE&G" or the "Company") where I am a Senior Engineer in Transmission Planning.

Q. PLEASE DESCRIBE YOUR EDUCATIONAL AND BUSINESS BACKGROUND.

A. I am a graduate of Clemson University with a Bachelor of Science degree in Electrical Engineering. I am a registered Professional Engineer in the State of South Carolina.

I began working for SCE&G in 2008 as a System Controller. I was transferred to Operations Planning as an Associate Engineer in 2010 and then to Transmission Planning as an Associate Engineer in 2012. I was promoted to Engineer IV in 2014 and to my current position of Senior Engineer in 2017.

Q. ARE YOU A MEMBER OF ANY INDUSTRY COMMITTEES FOR SYSTEM RELIABILITY ASSESSMENT OR PLANNING?

A. Yes, I am currently the representative for SCE&G on the Southeastern Reliability Corporation ("SERC") Long Term Study Group, and the SERC Dynamics Study Group. Additionally, I am a member of the Carolinas Transmission Coordination Agreement Power Flow Study Group and Dynamics Study Group and the Eastern Interconnection Planning Collaborative Steady State Model Load Flow Working Group.

All of these committees are directly involved with assessing the current and future capabilities of the integrated transmission grid in North America, the Southeast, and the Carolinas.

Q. PLEASE SUMMARIZE YOUR DUTIES AS A SENIOR ENGINEER IN TRANSMISSION PLANNING.

A. I am responsible for preparing the planning and associated analyses of the SCE&G electric transmission system to ensure compliance with required transmission planning and operating standards and criteria, as discussed below, and to ensure the safety, reliability, adequacy and cost effectiveness of the internal SCE&G transmission system as well as the interconnection transmission facilities with neighboring utilities.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THIS COMMISSION?

A. Yes. I have testified once before in a transmission siting proceeding.

Q. PLEASE DESCRIBE THE PURPOSE OF YOUR TESTIMONY IN THIS PROCEEDING.

A. The purpose of my testimony is to describe for the Commission the transmission upgrade projects that were undertaken as part of the project to construct two new nuclear units (the "Units") at the V.C. Summer site (the "NND Project"). These transmission upgrade projects (the "Transmission Upgrade Projects") are not being abandoned but have been or will be placed in service to meet the demands of our customers. My testimony explains why these Transmission Upgrade Projects have come to form a necessary part of SCE&G's transmission system even though the NND Project has been canceled. As explained below, SCE&G's transmission system could not meet federally mandated Transmission Planning Standards without the Transmission Upgrade Projects.

Q. HOW IS YOUR TESTIMONY ORGANIZED?

A. My testimony is organized into the following sections:

I. Description of SCE&G's Transmission System

II. The NND Project and Transmission Upgrade Projects

III. Current Need for the Transmission Upgrade Projects

IV. Conclusion.

I. DESCRIPTION OF SCE&G'S TRANSMISSION SYSTEM

Q. PLEASE DESCRIBE SCE&G'S TRANSMISSION SYSTEM.

A. SCE&G operates a transmission system that serves load centers in southern and central South Carolina including the metropolitan areas of Columbia, Charleston, Town of Lexington, Aiken, Orangeburg and Beaufort. The SCE&G transmission system is interconnected with the transmission systems of Georgia Power Company,

the South Carolina Public Service Authority ("Santee Cooper"), the Southeastern Power Administration ("SEPA"), Duke Energy Carolinas and Duke Energy Progress, which provides a pathway for power transfers and reserve sharing among those systems. SCE&G's transmission system directly connects SCE&G's approximately 5,840 megawatts of generating capacity with the distribution system that serves SCE&G's approximately 624,000 native load distribution customers.

SCE&G's transmission system is divided into a northern and southern region. The northern region includes the Columbia, Town of Lexington, Orangeburg, Batesburg-Leesville, and Aiken areas. The southern region includes the South Carolina Lowcountry including the Charleston, Summerville, Mt. Pleasant, Walterboro and Beaufort areas.

Q. HOW ARE SCE&G'S GENERATION ASSETS DISTRIBUTED WITHIN THE SERVICE TERRITORY?

A. For a number of reasons, including the historical availability of high-volume natural gas pipelines, rail service, land-use patterns and environmental restrictions, the majority of SCE&G's generation resources are located in the northern transmission region. For that reason, principal power flows on the system are north to south. There are, however, times when power flows are reversed and generation located in the southern region supports loads in the northern region. This occurs most often in off-peak periods when major generating units in the northern transmission region are out of service for planned outages such as nuclear refueling and maintenance or when unplanned outages occur. In addition, SCE&G's principal interconnections with Duke

Energy Carolinas, Duke Energy Progress and Georgia Power are located in the northern region. These flows between the northern and southern transmission regions will be substantially carried along a continuous path created by the Transmission Upgrade Projects, which establish a backbone through the center of the SCE&G transmission system.

Q. PLEASE EXPLAIN THE ROLE PLAYED BY THE SWITCHYARDS AND INTERCONNECTIONS LOCATED AT THE V.C. SUMMER SITE.

A. The switchyards and interconnections at the V.C. Summer site represent an important transmission asset for SCE&G. Approximately 22% of SCE&G's total current generation resources, or 1,290 MW, is located at the V.C. Summer site. The highest capacity lines serving the Columbia load center originate from the V.C. Summer site. Also located at that site are important 230 kV interconnections with the Santee Cooper and Duke Energy Carolinas transmission systems.

II. THE NND PROJECT AND TRANSMISSION UPGRADE PROJECTS

Q. PLEASE DESCRIBE HOW THE PROPOSAL WAS MADE TO CONSTRUCT THE TRANSMISSION ASSETS THAT WERE UNDERTAKEN AS PART OF THE NND PROJECT.

A. SCE&G's electric transmission system is regulated by the Federal Energy Regulatory Commission ("FERC") under statutory authority granted to that agency by the Federal Power Act, the Energy Policy Act of 2005, and other federal statutes. Under FERC Order No. 2003, SCE&G is required to provide non-discriminatory generator interconnection services to qualifying generators seeking to interconnect

generation facilities to its transmission system. As a part of that obligation, SCE&G must evaluate interconnection requests by its own generation planners using the same processes and procedures it uses to evaluate generator interconnection requests made by third-party generation developers. SCE&G used the FERC-approved process to identify the required transmission upgrades necessary to interconnect the NND Project.

Q. HOW HAVE THE TRANSMISSION UPGRADE PROJECTS IMPROVED THE OPERATION OF THE SCE&G TRANSMISSION SYSTEM?

A. The Transmission Upgrade Projects improve both the reliability and resiliency of the SCE&G transmission system. Prior to improvements, the existing facilities consisted of direct-embedded wooden-framed structures, many of which were 40 years old or older. These facilities have lower performance, higher maintenance costs, and a shorter life expectancy than the alternatives commonly used today. The Transmission Upgrade Projects utilize stronger materials and newer design standards that increase asset performance, reduce maintenance costs, and increase life expectancy. They use bundled aluminum conductors and enhanced hardware and are attached to self-supporting steel structures capable of withstanding increased loading conditions due to wind and ice. By hardening the transmission system, SCE&G has greatly reduced the likelihood of damage or other detrimental impacts caused by extreme weather events, such as hurricanes, ice storms and other storms, and is also increasing its ability to restore service quickly after an event. Additionally, rebuilding the lines from a horizontal configuration to a vertical configuration allowed SCE&G

to maximize power flow through the existing right-of-way, which increases the reliability of the transmission system.

Q. HAVE THE BENEFITS OF THESE IMPROVEMENTS BEEN REALIZED?

A. Yes, the Transmission Upgrade Projects constructed and integrated into SCE&G's transmission system are already providing both immediate and long-term benefits. By enhancing and modernizing SCE&G's transmission system with these assets, SCE&G has experienced improved reliability and had the opportunity to eliminate other transmission upgrades that would have been required absent the Transmission Upgrade Projects. Two examples illustrative of these benefits are the system's performance during Hurricane Matthew and Hurricane Irma. In these storms, no outages occurred.

These facilities also provide enhanced interconnection between SCE&G, Duke Energy Carolinas and Santee Cooper and provide greater opportunity for these systems to provide support for each other. These assets are in every respect used and useful.

Q. HOW DID SCE&G'S TRANSMISSION PLANNING GROUP EVALUATE INTERCONNECTION REQUESTS FOR V.C. SUMMER UNITS 2 & 3?

A. In 2006, after SCE&G's generation planners had laid the groundwork for the NND Project, SCE&G's NND group submitted to the Transmission Planning group the necessary documentation to request the interconnection of V.C. Summer Units 2 and 3 under the FERC Large Generator Interconnection Procedure ("LGIP") in effect at the time. Transmission Planning evaluated the request in light of the

forecasted growth in system dispersed demand over the coming decade and the requirements for reliably serving that growth. The modeling conducted at that time indicated that to meet customers' future needs reliably, SCE&G would be required to strengthen the transmission system's ability to deliver power into the Charleston area and Lowcountry by constructing a north-south backbone through the center of the SCE&G system. It also would require additional capacity to deliver power into the rapidly developing area around Lake Murray, Chapin, Irmo and the Town of Lexington, and into the rapidly developing Interstate 77 corridor around Blythewood, Killian and northeast Columbia. Transmission Planning designed the transmission upgrades associated with the NND Project to meet those customer needs.

Q. WAS THE NND PROJECT APPROVED BY THE COMMISSION?

A. Yes. In 2009, the Public Service Commission of South Carolina issued Certificates of Public Necessity, Convenience and Environmental Compatibility for the construction of the Units and the associated transmission upgrades and determined that the construction of the Units and the associated transmission upgrades were prudent. (Order No. 2009-104(A).) At that point, SCE&G's transmission group undertook to construct the necessary transmission upgrades to deliver the additional power to its customers.

Q. PLEASE DESCRIBE THE TRANSMISSION FACILITIES AND UPGRADES THAT WERE BUILT AS PART OF THE NND PROJECT.

A. The transmission facilities and upgrades that were built as part of the NND project (the "Transmission Upgrade Projects") include the following:

1. The V.C. Summer Switchyard No. 1 (VCS1)–Killian 230 kV Line.
2. The V.C. Summer Switchyard No. 2 (VCS2).
3. The VCS1–VCS2 230 kV Bus Ties No. 1, No. 2 and No. 3.
4. The VCS2–Lake Murray Substation 230 kV Line No. 2.
5. The new Saluda River 230 kV/115 kV Substation.
6. The new St. George 230 kV Switching Station.
7. The VCS2–St. George 230 kV Lines No. 1 and No. 2.
8. The Canadys–St. George 230 kV Line upgrade.
9. The St. George–Summerville 230 kV Line No. 1 upgrade.
10. VCS1 Switchyard Upgrades and related relocates.
11. McMeekin–Lyles 115 kV Line No. 1: Upgrade Saluda River–Lyles segment and fold-in at Saluda River 230 kV/115 kV Substation.
12. Denny Terrace–Lyles 230 kV Line upgrade including 230 kV terminal upgrades.
13. Saluda Hydro–Bush River 115 kV No. 1 and No. 2 upgrade to a portion of the lines to double circuit 1272 ACSR conductor.
14. Saluda Hydro–McMeekin – Lake Murray substations area 115 kV lines and substation upgrades.

In addition, fault current studies were conducted to identify breakers that required replacement or upgrading in light of the anticipated future load flows and the stress that interrupting increased load flows would place on existing breakers. All told, 22 individual breakers were replaced or upgraded. A list of those breakers is attached to my testimony as ***Exhibit __ (JWR-1).***

Q. WAS THE CONSTRUCTION OF THESE LINES, THE NEW SWITCHYARD, THE NEW SUBSTATION AND THE NEW SWITCHING STATION APPROVED BY THE COMMISSION UNDER THE UTILITY FACILITY SITING AND ENVIRONMENTAL PROTECTION ACT?

A. Yes. The Commission approved the construction of these lines, switchyard, substation and switching station, mostly in Order No. 2011-978 and Order No. 2012-730. In each of these proceedings, SCE&G presented planning studies and testimony establishing the need for these facilities. The Office of Regulatory Staff presented corroborating testimony, and in both cases a settlement agreement or stipulation was issued. Based on that record, the Commission determined that the improvements were necessary for the reliable operation of the transmission system and would support system economy and reliability. Once that determination was made, SCE&G proceeded with the projects. (Order No. 2011-978 at p. 11; Order No. 2012-730 at p. 12.)

Q. COULD YOU DESCRIBE IN NON-TECHNICAL TERMS THE LOCATION OF EACH OF THESE FACILITIES AND THE BENEFITS THEY PROVIDE?

A. Yes. The location of these lines and other facilities are shown on the map attached to my testimony as ***Exhibit __ (JWR-2).*** I will discuss each of the 14 upgrade projects separately.

The VCS1–Killian 230 kV Line represents a new approximately 39 mile 230 kV line which allows power from the V.C. Summer site and the switchyards located at that site to be delivered to the rapidly growing area along the Interstate 77 corridor north of Columbia, including Blythewood, Killian and Northeast Columbia. The VCS1–Killian 230 kV Line provides a very valuable additional transmission source to meet the needs of these areas northeast of Columbia and the northern sector of the Columbia metropolitan area generally and prevents potential system operating limit violations in this growing area.

The V.C. Summer Switchyard No. 2 expands SCE&G's ability to terminate or interconnect lines at the V.C. Summer site, including lines from other transmission systems. V.C. Summer Switchyard No. 1 was built in the late 1970s and is surrounded by generation facilities such that it cannot be further expanded. With the addition of the VCS1–Killian 230 kV line, it became impossible to terminate additional lines or add additional interconnections at the V.C. Summer site without the addition of the new switchyard. For that reason, the VCS2–St. George 230 kV Lines No. 1 and No. 2, the VCS2–Lake Murray Substation 230 kV Line No. 2, and the two recently constructed Santee Cooper Pomaria 230 kV Tielines would not have been possible without V.C. Summer Switchyard No. 2. The new switchyard also greatly increases

the ability to transfer power through the interconnections between SCE&G, Santee Cooper, and Duke Energy Carolinas.

The VCS1–VCS2 230 kV Bus Ties No. 1, No. 2 and No. 3 link Switchyard No. 1 and Switchyard No. 2 at the V.C. Summer site. These bus ties replaced three lines that were relocated from VCS1 to VCS2. These three lines were moved to VCS2 because their paths crossed through the VCS2 footprint.

The VCS2–Lake Murray Substation 230 kV Line No. 2 is a 230 kV transmission line of approximately 20 circuit miles that connects Switchyard No. 2 at the V.C. Summer site to the existing Lake Murray Substation. The new VCS2–Lake Murray Substation 230 kV Line No. 2 provides additional power delivery capability to serve in the rapidly growing areas surrounding Lake Murray, Irmo, Chapin and the Town of Lexington.

The Saluda River 230 kV/115 kV Substation (the "Saluda River Substation") is a new substation that provides the means for power to be delivered to customers in the northern parts of the Columbia metropolitan area including West Columbia, Cayce, Springdale and the western part of the downtown core of Columbia. The transmission facilities that were serving these locations before the Saluda River Substation was built are located in highly developed areas and would be very difficult and costly to expand if it would be possible to do so at all. Specifically, among its other benefits to the system, building the Saluda River Substation enabled SCE&G to cancel the planned re-build of the Denny Terrace–Lyles 115 kV transmission line. The VCS2–St. George 230 kV Line No. 2 is tied into the new Saluda River Substation creating an important

new path for power to be delivered into the western portion of the Columbia metropolitan area from either the northern or southern region of the system. As explained in the prior transmission siting proceedings, the Saluda River Substation was chosen as a lower cost alternative to upgrading the 230/115 kV transformation in certain substations in the area that would have become overloaded due to growth and customer demand. The current physical size of these certain substations would not have supported the upgrades.

The St. George 230 kV Switching Station (the "St. George Switching Station") is located at the point where lines that were formerly known as the Wateree–Summerville 230 kV line and the Canadys (SCE&G)–Sumter (DEP) 230 kV Tieline crossed without connection. The St. George Switching Station forms an important interconnection between SCE&G's system and that of Duke Energy Progress and prevents previously identified future NERC Reliability Standards system operating limit violations that would have required correction. After the VCS2–St. George 230 kV lines are complete, the St. George Switching Station will serve as a hub allowing power to be delivered to SCE&G's transmission and distribution systems serving Charleston, Summerville, Mt. Pleasant, Beaufort, Walterboro and the Lowcountry generally. Having a switching station at this location gives SCE&G's system operators greatly increased flexibility in managing power flows across the system and in responding to events on the system that require specific lines to be isolated.

The VCS2–St. George 230 kV Lines No. 1 and No. 2 represent approximately 208 circuit miles of new high-voltage 230 kV lines that strengthen the

north-south backbone of the transmission system. These lines link Switchyard No. 2 at the V.C. Summer site, which is located at the northern end of the system, to the new St. George switching station, which will serve as a hub for distributing power throughout the Lowcountry. The new VCS2–St. George 230 kV Lines greatly increase the ability to transfer power between the northern and southern regions of our system. In addition, as I mentioned earlier, in 2017, approximately 22% of SCE&G's generation resources were located at the V.C. Summer site, and it is the site of important interconnections with Santee Cooper and Duke Energy Carolinas. The new VCS2–St. George 230 kV Lines create a strong and direct link between this site, the rest of the northern transmission region, and the generation resources and load centers in the southern region.

Along the way, the VCS2–St. George 230 kV Lines No. 1 and No. 2 also provide additional ability to deliver power to the Orangeburg East Substation and the new Saluda River Substation. The connections to these substations greatly improves the ability to deliver power to the West Columbia, Cayce, Bush River Road, Whitehall, Lyles and Columbia Vista areas surrounding the Saluda River Substation and the Orangeburg area surrounding the Orangeburg East Substation.

The Canadys–St. George 230 kV Line is a 230 kV transmission line of approximately 10 circuit miles which connects St. George 230 kV Switching Station to the existing Canadys Substation and consists of an upgraded section of the former Canadys (SCE&G)–Sumter (DEP) 230 kV Tieline from St. George Switching Station to Canadys Substation. The Canadys Substation had previously routed approximately

385 MW of generation at Canadys Generating Station to load centers in the Lowcountry elsewhere. With the retirement of the Canadys Generation Station, the upgraded transmission connection allows that power to be replaced from other sources. Additionally, much like St. George Switching Station, Canadys Substation serves as a hub allowing power to be delivered to SCE&G's transmission and distribution systems with 230 kV connections to Savannah River Site Substation, Cope Substation, A.M. Williams Substation, Yemassee Substation and Church Creek Substation. A strong connection between Canadys Substation and St. George Switching Station strengthens the entire central and southern portion of SCE&G's system.

The St. George–Summerville 230 kV Line No. 1 is a 230 kV transmission line of approximately 30 circuit miles which connects St. George 230 kV Switching Station to the existing Summerville Substation and consist of an upgraded section of the former Wateree–Summerville 230 kV line from St. George Switching Station to Summerville Substation. This upgraded circuit provides additional power delivery capability to serve customers in the Lowcountry including the areas surrounding Summerville and Charleston.

VCS1 Switchyard upgrades and related relocates were necessary projects in order to facilitate the connection of new SCE&G and Santee Cooper transmission lines and the relocation of existing lines. This project also included upgrading existing breakers at the V.C. Summer site.

McMeekin–Lyles 115 kV Line No. 1: Upgrade Saluda River–Lyles segment and fold-in at Saluda River 230 kV/115 kV Substation projects were required to avoid overloading the section of the McMeekin – Lyles 115 kV Line between Saluda River and Lyles due to the heavy power flow anticipated through the Saluda River Substation.

Denny Terrace–Lyles 230 kV Line upgrade including 230 kV terminal upgrades are necessary projects to serve the downtown Columbia area and to meet necessary criteria to prevent overloaded conditions.

Saluda Hydro–Bush River 115 kV No. 1 and No. 2: Upgrade a portion of the lines to double circuit 1272 ACSR project was necessary to accommodate the use of existing right of way in constructing the VCS2–Lake Murray 230 kV No. 2 Line and the VCS2–St. George 230 kV No. 1 Line. The construction plan for the VCS2–Lake Murray 230 kV No. 2 Line and the VCS2–St. George 230 kV No. 1 Line required existing lines, including the Saluda Hydro–Bush River 115 kV No. 1 and No. 2 lines, to be taken out of service and rebuilt on new structures. Vertical structures were needed rather than lattice work towers to accommodate the additional lines. Old conductors were replaced, which was standard procedure, as they cannot be reused. The original structures were outdated.

Saluda Hydro – McMeekin – Lake Murray substations area 115 kV lines and substation upgrades projects were necessary to increase the capacity of these lines to accommodate the construction plan as discussed above.

III. CURRENT NEED FOR THE TRANSMISSION UPGRADE PROJECTS

Q. NOW THAT THE NND PROJECT HAS BEEN CANCELED, HAVE YOU CONDUCTED TRANSMISSION PLANNING STUDIES SHOWING THAT THE TRANSMISSION UPGRADE PROJECTS ARE NECESSARY NONETHELESS FOR THE RELIABLE OPERATION OF THE TRANSMISSION SYSTEM?

A. Yes. In order to demonstrate the benefits of the Transmission Upgrade Projects to the system in the absence of the NND Project, SCE&G's transmission planners have conducted a study of the system assuming none of these assets had been constructed. The results of these analyses are set forth on ***Exhibit __ (JWR-3).***

Q. WHAT TRANSMISSION PLANNING STANDARDS DID YOU USE IN PREPARING THESE ANALYSES?

A. In preparing these analyses, we followed the same standards and criteria that are used consistently in SCE&G's transmission planning studies under the mandatory North American Electric Reliability Council ("NERC") Transmission Planning Standards including NERC Reliability Standard TPL-001-4. Under this Reliability Standard, SCE&G is required each year to conduct a Planning Assessment of its transmission system for various on and off peak seasons within multiple time periods including: the next year, five years into the future, and six to ten years into the future. In preparing these analyses, Transmission Planning also applied SCE&G's system-specific Long-Range Planning Criteria, which supplement the NERC Transmission Planning Standards. The Long-Range Planning Criteria are

transmission planning criteria that SCE&G has adopted in light of its system attributes and consistently applies in its long-range transmission modeling.

Q. WHAT ARE THE OUTCOMES YOU SEEK TO ACHIEVE IN TRANSMISSION PLANNING?

A. One of the goals of transmission planning is to ensure compliance with TPL-001-4 and SCE&G's internal planning criteria which require the transmission system to maintain reliable transmission service and system stability with no impacts more serious than local load loss in response to reasonably anticipated events. These reasonably anticipated events include the failure of one or more of any of SCE&G's generation or transmission assets. Transmission planning models simulate the power flows that would result from such events and their impact on the stability of the system and the integrity of transmission and generation equipment. The goal is to ensure that the system will still be able to serve all non-radial loads and operate within system operating limits ("SOLs") going forward even if one or more of these reasonably anticipated contingencies or events occurs.

Q. HOW MANY LEVELS OF CONTINGENCIES DO YOU MODEL?

A. The events and conditions are modeled under the NERC Reliability Standard requirements that provide for multiple levels of analysis. The first includes the loss of any single transmission or generation asset (N-1). A second level of the analysis models the response of the system to the loss of any transmission or generation asset, followed by appropriate switching and re-dispatching, and then followed by the loss

of any other transmission or generation asset (N-1-1). A third level of analysis measures the simultaneous loss of two transmission or generation assets (N-2).

Under any of these circumstances, the goal of transmission planning is to ensure that system stability can be maintained and the stress on any transmission or generation asset would be held within acceptable limits. The failure to identify and mitigate SOLs violations can result in widespread loss of service to customers and long-term damage to transmission or generation assets, which could make the restoration of electric service to customers a long, difficult and expensive process. They also constitute a violation of NERC and FERC standards, which can result in sizable fines and penalties.

Q. WHAT CONSTITUTES AN UNACCEPTABLE LOADING OF A TRANSMISSION OR GENERATION ASSET AND WHAT MUST YOU DO IN RESPONSE?

A. The operative loading factors that are relevant here concern the thermal loading of transmission assets, including lines and transformers. Under mandatory NERC requirements, a plan must be formulated and implemented to correct or mitigate any thermal loading that exceeds 100% of an asset's thermal rating. Under SCE&G's Long-Range Planning Criteria, any asset which is thermally loaded to 90% or more of its thermal rating is considered heavily loaded and a plan must be undertaken to correct or mitigate that loading.

Q HOW DID YOU ANALYZE THE BENEFITS TO THE SYSTEM OF THE TRANSMISSION UPGRADE PROJECTS UNDER CONSIDERATION HERE?

A. In assessing the necessity and benefits of the Transmission Upgrade Projects that were part of the NND project, we have modeled the N-1, N-1-1 and N-2 scenarios for Summer Peak, Fall Peak, Winter Peak, Shoulder Load and Light Load for 2018-2019, 2019-2020, 2022-2023, and 2027-2028.

Q. WHAT DID THESE ANALYSES SHOW?

A. These analyses show that without the Transmission Upgrade Projects, a substantial number of SCE&G's transmission facilities would be overloaded or heavily loaded beginning in the near term, and the number of overloaded and heavily loaded facilities increases as time progresses. Without the Transmission Upgrade Projects, thirty-seven 230 kV and 115 kV transmission lines, totaling approximately 571 miles, will be overloaded or heavily loaded and eight high-voltage transformers will be overloaded or heavily loaded totaling 2352 MVA of transformer capacity. Transmission upgrades of the sort provided by the Transmission Upgrade Projects would be required to correct these problems.

Q. WHY ARE TRANSMISSION UPGRADE PROJECTS OF SUCH VALUE TO SCE&G'S TRANSMISSION SYSTEM?

A. The Transmission Upgrade Projects represent upgrades to core components of SCE&G's transmission system. They directly increase SCE&G's ability to deliver

power between the northern and southern regions of its transmission system. Because these are upgrades to core transmission corridors, they create a flexible and resilient transmission system to serve customers and allow us to meet growth in our service territory reliably and efficiently. These upgrades have been designed to allow the transmission system to meet growing customer load. They are valuable regardless of the precise location of generation resources. The fact that the NND Project has been canceled does not change the benefits or appropriateness of the transmission upgrades that have been constructed as part of that Project. From my perspective, these are precisely the sorts of upgrades that provide the most long-term benefit to the system.

Q. DO THE TRANSMISSION PROJECT UPGRADES DISCUSSED ABOVE RESULT IN LOWER LINE LOSSES?

A. Yes. Our modeling shows that the Transmission Upgrade Projects result in an 11 MW reduction in losses on the system during system peak. This represents a significant amount of energy and capacity savings. Reduced losses produce real savings that will occur in every hour of the year and result in less fuel burned and less capacity needed. It also demonstrates the efficiency and operational flexibility that the Transmission Project Upgrades provide to the system.

Q. HAVE YOU PERFORMED ANY ANALYSIS CONCERNING THE CIRCUIT BREAKER UPGRADES THAT WERE INCLUDED AS PART OF THE PROJECT?

A. Yes. Transmission Planning performed a short circuit analysis to determine whether the system would function effectively if the breaker upgrades had not been

completed as part of the Transmission Upgrade Projects. Transmission Planning modeled breaker performance based on SCE&G's transmission system present planning horizon. The model evaluated peak short-circuit current under two scenarios: one with the Transmission Upgrade Projects removed, breaker upgrades removed and all existing generators available and online; a second with the Transmission Upgrade Projects removed, breaker upgrades removed, all existing generators available and online, and, for the sole purpose of this analysis, a new combined cycle facility sited at the Parr 230 kV bus to replace part of a nuclear generator. In this analysis, breakers that were replaced as part of the NND Project in 2018 would have been rated as either marginal or stressed if they had not been replaced, as shown on ***Exhibit __ (JWR-1)***. Such rating would have put them on the schedule for replacement or upgrading. The exception would be the twelve breakers that were replaced in the Unit 1 switchyard. Six of these breakers were 40-year-old breakers of a unique design. They required increased maintenance and spare parts for these breakers were increasingly difficult to find. For these reasons, they would have required replacement in the near term had they not been replaced as part of the NND Project. The remaining two breakers that were replaced have been maintained as spare breakers and continue to provide benefits to the system.

IV. CONCLUSION

Q. COULD YOU PLEASE SUMMARIZE YOUR CONCLUSIONS FOR THE COMMISSION?

A. The analysis that Transmission Planning has conducted clearly shows the benefits of the Transmission Upgrade Projects to the safe and reliable operation of SCE&G's transmission system even with the cancellation of the NND Project. Without the Transmission Upgrade Projects, the system would fail to meet critically important Reliability Standards requirements today, and the situation would grow progressively worse with time. The failure to meet these critically important Reliability Standard requirements would potentially subject SCE&G to penalties from the FERC/NERC. In addition, the Transmission Upgrade Projects consist of upgrades to the core assets allowing SCE&G's system to deliver power between the northern and southern regions of the transmission system. Transmission upgrades to support service to growing customer needs would be required with or without the addition of new nuclear generation to the system. For these reasons, the Transmission Upgrade Projects constitute assets which are not being abandoned and are used and useful in providing electric service to SCE&G's customers.

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes.

Preface

In the System Impact Studies (SIS) reports for V.C. Summer Units #2 and #3, circuit breaker upgrades were identified due to the additional generation and the Transmission Upgrade Projects. Transmission Planning has now performed a thorough short circuit study of the SCE&G system to determine the effect on the previously proposed circuit breaker upgrades without V.C. Summer Units #2 and #3 and populated the following report.

Short Circuit Analysis

The following basecase was used for this study:

- 2018-2019 winter peak short circuit basecase with all Transmission Project Upgrades in place except for circuit breaker upgrades – all existing generators available and online.

The study simulated faults at each of the circuit breaker locations in Table 1 and compares the fault magnitude against the circuit breaker rated interrupting capability prior to the circuit breaker upgrade. The results are listed in Table 1 below.

All of the circuit breakers at VC Summer Sub #1 were the original 63kA oil circuit breakers with the exception of two 63kA SF6 circuit breakers. There were no others circuit breakers on SCE&G's system like these VC Summer Sub #1 oil circuit breakers; there were no others circuit breakers at VC Summer Sub #1 like these two 63kA SF6 circuit breakers. Spare parts were difficult to obtain for these 40+ year-old circuit breakers. Also, standardization is necessary at a nuclear facility where uniformity is critical. For these reasons, the circuit breakers at VC Summer Sub #1 needed to be replaced even without the Transmission Project Upgrades.

The remaining circuit breakers in the Table 1 list were determined to be either "overstressed" or "marginal" (marginal is defined as within 10% of becoming overstressed). Also, the majority of these circuit breakers are older oil type circuit breakers which require more maintenance and have an increasing scarcity of replacement parts. For these reasons, these remaining circuit breakers would likely have been replaced even without the Transmission Project Upgrades in place.

Table 1

Breaker ID	Sub ID	Sub Name	kV	Rate	Type	With Transmission Project Upgrades
8032	2045	Denny Terrace Sub	115	47	Oil	Stressed
8042	2045	Denny Terrace Sub	115	40	SF6	Marginal
8092	2045	Denny Terrace Sub	115	40	Oil	Stressed
2712	2046	Edenwood Sub	115	43	Oil	Stressed
3052	2046	Edenwood Sub	115	43	Oil	Stressed
3672	2046	Edenwood Sub	115	43	Oil	Stressed
3682	2046	Edenwood Sub	115	43	Oil	Stressed
1051	2451	McMeekin Sub	115	40	SF6	Stressed
2051	2451	McMeekin Sub	115	40	SF6	Stressed
562	2481	Saluda Hydro Sub	115	47	Oil	Stressed

Breaker ID	Sub ID	Sub Name	kV	Rate	Type	With Transmission Project Upgrades
8722	2561	VC Summer Sub #1	230	63	Oil	Meets Breaker Capability
8772	2561	VC Summer Sub #1	230	63	Oil	Meets Breaker Capability
8792	2561	VC Summer Sub #1	230	63	Oil	Meets Breaker Capability
8822	2561	VC Summer Sub #1	230	63	Oil	Meets Breaker Capability
8832	2561	VC Summer Sub #1	230	63	Oil	Meets Breaker Capability
8842	2561	VC Summer Sub #1	230	63	Oil	Meets Breaker Capability
8852	2561	VC Summer Sub #1	230	63	Oil	Meets Breaker Capability
8892	2561	VC Summer Sub #1	230	63	Oil	Meets Breaker Capability
8902	2561	VC Summer Sub #1	230	63	SF6	Meets Breaker Capability
8912	2561	VC Summer Sub #1	230	63	Oil	Meets Breaker Capability
8932	2561	VC Summer Sub #1	230	63	SF6	Meets Breaker Capability
8942	2561	VC Summer Sub #1	230	63	Oil	Meets Breaker Capability

Transmission EPC

Progress Chart Map

Legend

- Transmission Substations
- 115
- 230
- Interstate Highway
- County Line
- Project Highlight
- Major River
- Major Lake or River

0 5 10 15 20 Miles

SCE&G® A SCANA COMPANY

N W E S

Newberry
Fairfield
Kershaw
Richland
Lexington
Saluda
Aiken
Barnwell
Orangeburg
Calhoun
Sumter
Clarendon
Dorchester
Berkeley

Lake Monticello
Lake Wateree
Wateree R
Broad River
Lake Murray
Congaree River
North Fork Edisto River
South Fork Edisto River
Lake Marion
Santee
Cooper

Winnsboro
VCS1 Switchyard
VCS2 Switchyard
Winnsboro Junction
Parr
Chapin Junction
Blythewood
Killian
Denny Terrace Substation
Arrowood Junction
Zoo
Lyles Trans. Substation
Columbia
Saluda River Substation
Dunbar Rd
Dixiana
Gaston Junction
Orangeburg
301 Junction
St. George
Summerville 230 kV Substation

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14.

ID	PROJECT
1.	The V.C. Summer Switchyard No. 1 (VCS1) to Killian 230 kV Line.
2.	The V.C. Summer Switchyard No. 2 (VCS2).
3.	The VCS1-VCS2 230 kV Bus Ties No. 1, No. 2 and No. 3.
4.	The VCS2-Lake Murray Substation 230 kV Line No. 2.
5.	The new Saluda River 230 kV/115 kV Substation.
6.	The new St. George 230 kV Switching Station.
7.	The VCS2-St. George 230 kV Lines No. 1 and No. 2.
8.	The Canadys-St. George 230 kV Line upgrade.
9.	The St. George-Summerville 230 kV Line No. 1 upgrade.
10.	VCS1 Switchyard Upgrades and related relocates
11.	McMeekin – Lyles 115 kV Line No. 1: Upgrade Saluda River – Lyles 115 kV segment and fold-in at Saluda River 230 kV/115 kV Substation.
12.	Denny Terrace – Lyles 230 kV Line upgrade including 230 kV terminal upgrades
13.	Saluda Hydro – Bush River 115 kV No. 1 and No. 2: upgrade a portion of the lines to double circuit 1272 ACSR.
14.	Saluda Hydro – McMeekin – Lake Murray substations area 115 kV lines and substation upgrades.

6/14/2018

Path: H:\Desktop\NND Construction Map for Testimony\EPC Progress Chart Map_RCH.mxd

Preface

In the System Impact Studies (SIS) performed to evaluate interconnection of V.C. Summer Units #2 and #3, Power Flow analyses were performed. The Transmission Upgrade Projects, which will all be completed by the third quarter of 2018, were identified in the SIS reports due to the additional generation. Transmission Planning has now performed thorough studies of the SCE&G system without these upgrades and without V.C. Summer Units #2 and #3 and populated the following report.

Power Flow Analysis

N-1 Scenario

Without the Transmission Upgrade Projects in place, the SCE&G system has the following thermally heavily loaded facilities (>90%):

- Canadys – Church Creek 230 kV line
- Canadys – Goose Creek 230 kV line
- Canadys – SRS 230 kV line
- Coit – Edenwood 115 kV #2 line
- Edmund SS – Owens Corning 115 kV line
- McMeekin – Saluda Hydro 115 kV line
- Orangeburg East – St. George 115 kV #1 line
- Owens Corning – Toolebeck 115 kV line
- St. George – St. George 115 kV #1 SCPSA Tieline
- St. George – St. George 115 kV #2 SCPSA Tieline
- Stevens Creek – Thurmond 115 kV SEPA Tieline
- Urquhart – Toolebeck 115 kV line
- Orangeburg East 230/115 kV #1 Transformer
- Orangeburg East 230/115 kV #2 Transformer

Without the Transmission Upgrade Projects in place, the SCE&G system has the following thermally overloaded facilities:

- Dunbar Road – Orangeburg East 115 kV line (103%)
- Killian – Pineland 115 kV #2 line (104%)
- McMeekin – Lyles 115 kV line (112%)
- Okatie – McIntosh 115 kV SOCO Tieline (103%)
- Canadys 230/115 kV Transformer (112%)

N-1-1 and N-2 Scenarios

Without the Transmission Upgrade Projects in place, the SCE&G system has the following thermally heavily loaded facilities (>90%):

- Canadys – Goose Creek 230 kV line
- Church Creek – Faber Place 115 kV line
- Graniteville – Ward 230 kV line
- Graniteville #2 – Toolebeck 115 kV line
- Parr – Denny Terrace 115 kV #2 line
- Ritter – Yemassee 230 kV line
- Saluda Hydro – Bush River 115 kV #1 DEC Tieline
- Saluda Hydro – Bush River 115 kV #2 DEC Tieline

- VCS1 – Blythewood 230 kV SCSPA Tieline
- VCS1 – Parr 230 kV #1 line
- VCS1 – Parr 230 kV #2 line
- VCS1 – Ward 230 kV line
- Wateree – Sumter 230 kV DEP Tieline
- Yemassee – Yemassee 230 kV SCSPA Tieline
- Church Creek 230/115 kV #3 Transformer

Without the Transmission Upgrade Projects in place, the SCE&G system has the following thermally overloaded facilities:

- Barnwell – Denmark 115 kV line (101%)
- Canadys – Church Creek 230 kV line (119%)
- Canadys – SRS 230 kV line (102%)
- Coit – Edenwood 115 kV #2 line (100%)
- Coit – Williams Street 115 kV line (104%)
- Cope – Denmark 115 kV line (107%)
- Denny Terrace – Lyles 115 kV #2 line (106%)
- Dunbar Road – Orangeburg East 115 kV line (104%)
- Edenwood – Edmund SS 115 kV line (106%)
- Edmund SS – Owens Corning 115 kV line (100%)
- Jasper – Yemassee 230 kV #1 line (102%)
- Jasper – Yemassee 230 kV #2 line (102%)
- Killian – Pineland 115 kV #2 line (157%)
- McMeekin – Lake Murray 115 kV line (106%)
- McMeekin – Lyles 115 kV line (189%)
- McMeekin – Saluda Hydro 115 kV line (111%)
- Okatie – McIntosh 115 kV SOCO Tieline (103%)
- Orangeburg East – St. George 115 kV #1 line (125%)
- Stevens Creek – Thurmond 115 kV SEPA Tieline (101%)
- Canadys 230/115 kV Transformer (109%)
- Cope 230/115 kV Transformer (101%)
- Killian 230/115 kV Transformer (101%)
- Orangeburg East 230/115 kV #1 Transformer (116%)
- Orangeburg East 230/115 kV #2 Transformer (116%)
- Pineland 230/115 kV #1 Transformer (103%)
- Pineland 230/115 kV #2 Transformer (103%)

Summary

For the cases without the Transmission Upgrade Projects in service, approximately 97 miles of 115 kV line, approximately 124 miles of 230 kV line and one transformer with a total of 224 MVA are heavily loaded; and approximately 180 miles of 115 kV line, approximately 171 miles of 230 kV line and seven transformers with a total of 2128 MVA capacity are overloaded.

These results back the statement that SCE&G's system is more reliable with the Transmission Upgrade Projects in service.